Wireless Access Points Placement Analysis on WI-FI Signal Coverage with BAYESIAN Probability Method

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***Abstract*—Wireless networks in a room are strongly influenced by *interference*. To overcome the interference and so that the *performance* from *the* wireless network is getting better, then optimization is done. There are several types of propagation that can interfere with the *performance* of wireless networks, which include the number of transmitters (*access points*), *free space loss*, *Received Signal Strength* (RSSI), *coverage* that can be served, measuring attenuation on barriers (concrete walls, soft partitions, doors, and floors).**

This research is an analytical study where the purpose of this study is to determine the position of *access point* a good in the Shari'ah Faculty Building and the Law using the method *of Bayesian probability.* The first stage of this research is to determine the distance of the signal reception to find out the strength of the signal with *manual random sampling* so that the data obtained varies. The second stage is to determine the position of the *access point* with a choice of several points so that the best position can be compared based on the plan of the Syari'ah Faculty and Law Building. The last step is calculating probability by the method *of Bayesian probability.*

The results of this study are the position of the *access point* best on the 3rd floor, namely at position B with a probability value of 13 while on the 4th floor the position of *access the point* best in position A with a value of 10, position D with a value of 13 and position E with a value of 13. The most influential propagation in the Syari'ah Faculty Building and the Law is a concrete wall with a size of 60% reducing the magnitude of the signal emitted.*(Abstract)*

Keywords: *Analysis, Wireless, Propagation, Access Point.*

I. INTRODUCTION

Today's computer network technology is very sophisticated. The development of network technology is very helpful for humans in doing daily work. Both in communicating and seeking information. In 1988 network technology began to be used in various agencies, including universities and companies. Network technology used is still cable-based, so there are many disadvantages both in terms of costs and in their inflexibility. The technology currently in use is wireless networks or wireless fidelity (Wifi).

Wireless network technology in a building or building will have many disturbances, including LOS (Line of Sight), position *access point*, signal strength, and so on. To overcome the disorder and so that the *performance* of the wireless network gets better, an optimization is done. The optimization model used is the propagation model, namely the theoretical and empirical models. The theoretical model is the measurement of propagation aspects which include the number of transmitters (*access points*), *free space loss*, *Received Signal Strength* (RSSI), *coverage* that can be served, measuring attenuation on barriers (concrete walls, soft partitions, doors, and floors). The empirical model of monitoring is done by observation.

This research was conducted to analyze the performance of the wifi network in the Syari'ah Faculty and Law building at Sunan Kalijaga UIN Yogyakarta. On this campus, since it was first established, it uses wireless networks, making it easier for the academic community to connect to the internet wherever they are. However, based on field surveys in the Faculty of Sharia and Law wirelessly still less than optimal network because there are areas that are not covered by network *a Wi-Fi* as well (blank spot). (Nugraha, 2016). Therefore, the author mapped the laying of the *access point* of the Syari'ah Faculty and Law with wireless LAN networks using the Bayesian probability method, where Bayesian probability will give the highest possible value of the position of the *access point* so that the area of the building will cover the wifi network properly.

II. RESEARCH PURPOSES

The objectives to be achieved in this study are:

1. Determine the best position in the installation of Access Point on the 3rd and 4th floors of the Faculty of Sharia and Law
2. In order for the Wi-fi signal to be optimally received by the user.

III. RESEARCH METHOD

The research method used in this study is to analyze the network architecture in the Faculty of Sharia and Law relating to Access Points. To obtain primary data, data retrieval is done using manual random sampling. Whereas to determine the placement of Access Points with high probability values, the Bayes probability method is used.

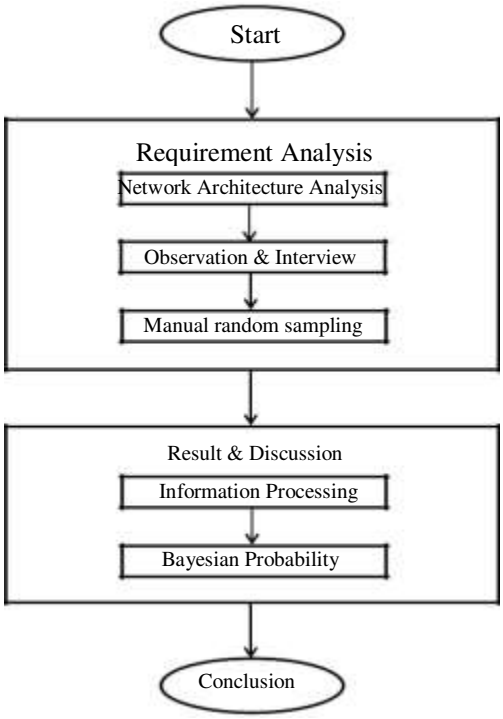

Figure 1. Research Flow Diagram

Research conducted using several research methods so that the objectives that have been determined can be done and achieved well. The research methods carried out are as follows:

A. *Interview Method*

This interview method was conducted to obtain information about the state of the previous Wi-fi signal by conducting interviews were carried out at the Information Technology and Database Center (PTIPD) on available equipment and information. Interviews were conducted with network management staff, namely Ramadhan Gatra as the Information Technology Division.

B. *Observation Method*

Observation made prior to conducting research are recording and recording the number of transmitters, number of rooms, size of RSSI (Radio Received Signal Strength), distance of signal range and type of propagation. The data collection was focused on the 3rd and 4th floors as the target of this study.

IV. RESULT & DISCUSSION

Based on the literature review and system analysis, the results achieved are the realization of the best positioning in the installation of *access points* so that thesignal *Wi-fi* can be optimally received by the user.

A. *Requirement Analysis*

After conducting interviews with Islamic State University of Sunan Kalijaga network administrators, the next step is to design the Syari'ah Faculty and Law building especially on the 3rd and 4th floors to find out the number of rooms and determine the position of the *access points* installed on each floor and to make it easier to use the application Ekahau Heatmapper as a signal detector from an *access point.* The following is a picture of floor plan 3.

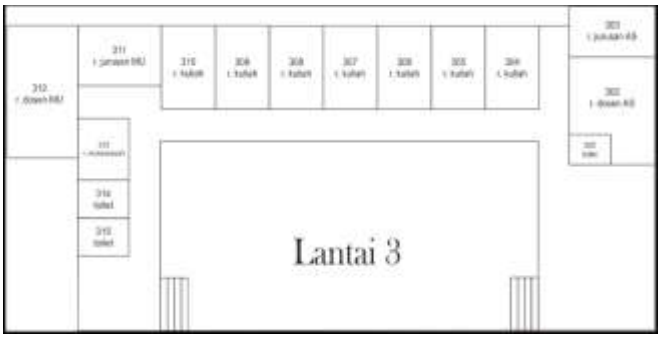

Figure 2. Floor Plan of 3rd floor of Faculty Sharia & Law

On the 3rd floor plan, it is known that there are 12 rooms used for academic purposes, namely spaces 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, and 313, and there are 3 toilet rooms. On that floor there is 1 (one) *access point* activeand 1 (one) *access point* that is not active, the active *access point* is located in front of room 304 and facing west.

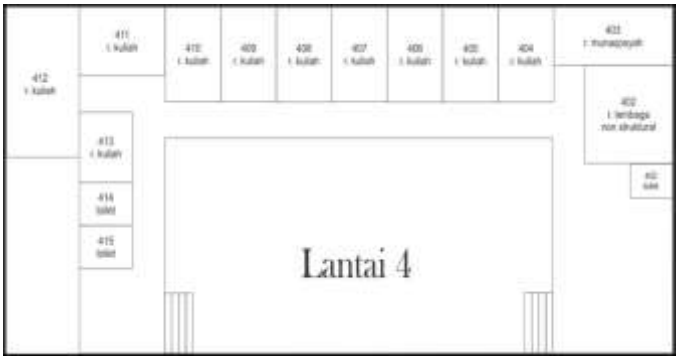

Figure 3. Floor Plan of 4th floor of Faculty Sharia & Law

On the 4th floor plan above, it can be seen that the structure of the building and the number of rooms on the 4th floor are not much different from the 3rd floor. On the 4th floor there are 12 rooms used for academic purposes namely spaces 402, 403, 404, 405, 406, 407 , 408, 409, 410, 411, 412 and 413, and 3 toilet rooms. There are 3 active access points installed on the 3rd floor, each in front of room 413 facing east, in front of room 407 facing north, and in front of room 404 facing west. Following is the table of observation data on the point of access point.

Table 1. Observation Data

Access Point		Room		Propagations	
Amount	Desc.	Amount	Desc.	Amount	Desc.
2	Located on 3rd floor, 1 access point is dead and 1 access point normal, position installation access point used is located at on space 304 and facing to the west.	15	On the 3rd floor has 3 parts, wich is the western part (R. 311, R.312, R. 313, R. 314, R. 315), the middle part (R. 304, R. 305, R. 306, R. 307, R. 308, R. 309, R. 310) & the eastern part (R. 301, R. 302, & R. 303)	12	Separating wall between rooms
3	Located on the 4th floor with circumstances the access point is normal, the position of the access point is in front of room 413 and facing east, in front of room 407 facing north and in front of room 404 facing west.	15	On the 4th floor has 3 parts, wich is the western part (R. 411, R.412, R. 413, R. 414, R. 415), the middle part (R. 404, R. 405, R. 406, R. 407, R. 408, R. 409, R. 410) & the eastern part (R. 401, R. 402, & R. 403)	12	Separating wall between rooms

B. Research Planning

1. Data Sample Selection

Preliminary analysis can be done to find out which rooms are not accessible by Wi-Fi signals using the Ekahau Heatmapper application.Below is an image from the 3rd and 4th floors which has been the result of the Ekahau Heatmapper application.

Figure 3. 3rd floor Ekahau Heatmapper result

From the picture above there are several problems found in the field, among others: Signal coverage from the *access point* does not cover well to all rooms on the 3rd floor, Placement of inappropriate access points, Barriers / propagation of concrete walls, doors and windows can causing the signal to weaken, there are some rooms that do not*cover* thesignal *Wi-Fi* properly, namely spaces 303, 310, 312 and 313 due to the placement of the *access point* that is less precise and there are some propagation which blocks signal transmission.

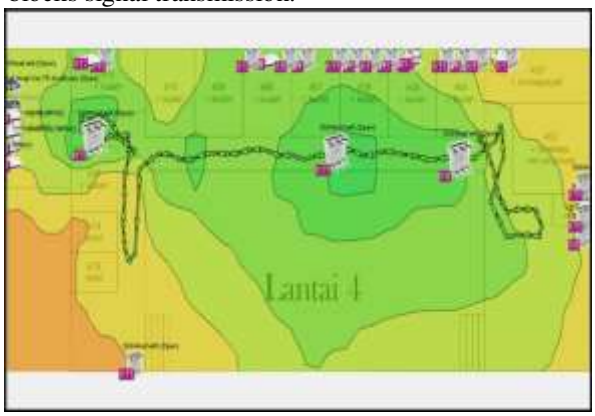

Figure 4. 4th floor Ekahau Heatmapper result

In the 4th floor plan, there are some problems found in the field, including the placement of an inaccurate access point causes the signal to be radiated less evenly. There is a barrier/propagation of the concrete wall, the door and window can cause the signal to weaken. does not cover the signal *Wi-Fi* properly, ie space 402, 403 and 313 due to the placement of *access the point* is incorrect and there are some propagations inhibits signal transmission.

2. Field Measurement

Incorrect placement of the *access point* is a factor of the spread of the signal *access point* evenly so that there will be several rooms or places that do not cover the signal properly. This can be caused because in the position of the *access point* the installed there is propagation (barrier) or other objects.

Positioning is based on field conditions, the presence of propagation and the distance of the *access point.* The following is a plan from several points of placement of access points that will be compared results using Bayesian probability.

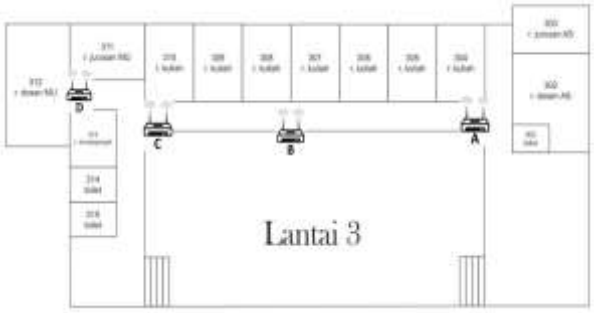

Figure 5. 3rd floor Access Point Installation mapping

The initial *point of the access point* that is active on the 3rd floor (three) is at point A, where at position A there are several problems as explained previously, so to reduce the problem there are 3 (three) placement point options namely point B, point C and point D. The distance between point A to point B is 20 meters, the distance between point B to point C is 30 meters, the distance between point C to point D is 10

meters. The point of placement of the *access point is* determined by multiples of 5 meters to be more efficient in using the number of *access point.*

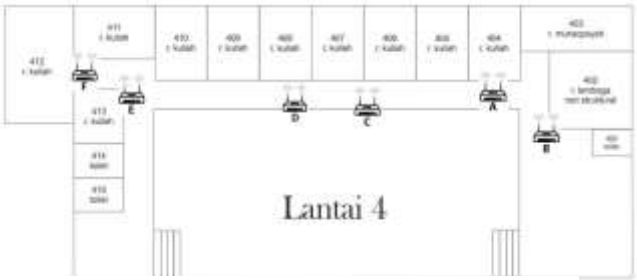

Figure 6. 4th floor Access Point Installation mapping

The option of the placement *access point* on the 4th floor will have 1 (one) point option that is used to be the comparison of the initial placement point. The initial placement point is at point A, point C, and point E. From the observations that have been made, it is known that the problem found on the 4th floor is not much different from the 3rd floor, the number of installed and active access points is different from the conditions on the 3rd floor. placement of *access points.* The placement option point A will be compared to point B, the placement option point C will be compared to point D and the option to place point E will be compared to point F.

3. Calculations

After the sample data and the determination of the positions are *access point* obtained for the next step, it is determining the opportunity parameters of each *evidence* contained during the research. *evidence* the used to process data using the method *of bayesian probability* which will be known the final result. Bayesian probability is one way to overcome uncertainty by using Bayes formula (Hartanti & Iswanti, 2008).

The first step the researcher will determine the opportunity parameters of the predetermined propagation, the following is the parameter table:

Table 2. The probability parameter of the propagation effect on the Wi-fi signal broadcast

No	Propagation	Signal strength (dBm) normal -35	P(E)	P(E|H)
1	Wind	-36	0.2	0.1
2	Wood	-41	0.2	0.2
3	Door(plywood)	-44	0.2	0.3
4	Glass	-52	0.2	0.5
5	Concrete Wall	-57	0.2	0.6

P (E) is the chance of the effect of propagation X if the position of access point X is bad, propagation X is a type of propagation that affects the position of access point X, access point X is the placement point that will calculate the level of opportunity. The value of P (E) is obtained from the opportunity value 1 divided by 5 types of propagation, namely 0.2.

Second, researchers will determine the distance effect probability on the signal. The farther the distance of the access point to the signal receiver, the weaker the signal is transmitted (Riza, 2012). When the researcher makes data collection on the installed access point, the distance is randomly determined to obtain various results. From Appendix A, a conclusion can be drawn with a graph that the distance has an effect on the strength of the weak signal emitted.

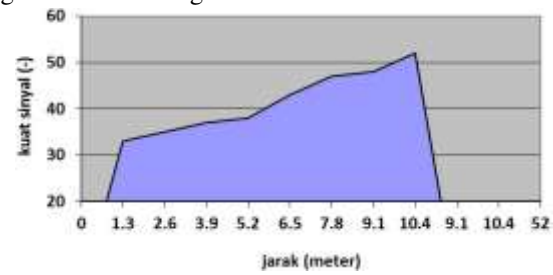

Figure 7. Relationship graph between distance and access point signal strength with mac address OC:85:25:F3:5C:D4 on 3rd floor

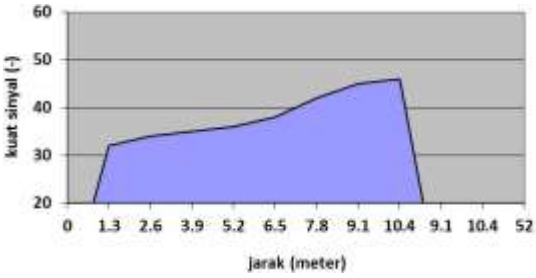

Figure 8. Relationship graph between distance and access point signal strength with mac address OC:85:25:F3:A8:D4 on 4th floor

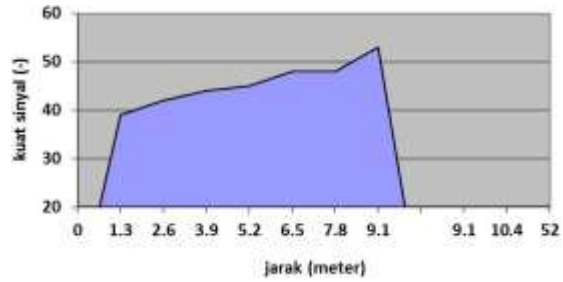

Figure 9. Relationship graph between distance and access point signal strength with mac address D8:24:BD:59:61:44 on 4th floor

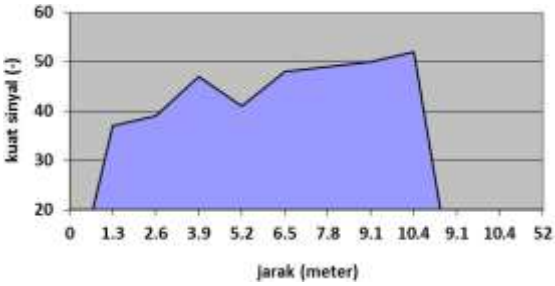

Figure 10. Relationship graph between distance and access point signal strength with mac address D8:24:BD:84:A9:D4 on 4th floor

After obtaining parameters and opportunity values from the available evidence, the next step is to calculate the

opportunity value of each access point position using the formula of bayesian probability.

4. Result & Discussion

The final result of the Bayesian probability calculation is the opportunity value of the position of the access point. The magnitude of the opportunity value affects the bad position of the access point. The greater the value, the worse the position of the access point, because the value of evidence propagation shows that the greater the value, the more propagation influences the distance of the access point and of course the distance will determine the bad position of the installation of the access point. Here are the result of bayesian probability calculations result :

Table 3. Bayesian probability calculation result for 3rd floor

Position	Amount
A	0.424
B	0.44
C	0.445
D	0.455

In table 3 it is known that the value of the four positions is different, and at position A has the smallest value of 0.424 so position A is the best position in the placement of access points on the 3rd floor.

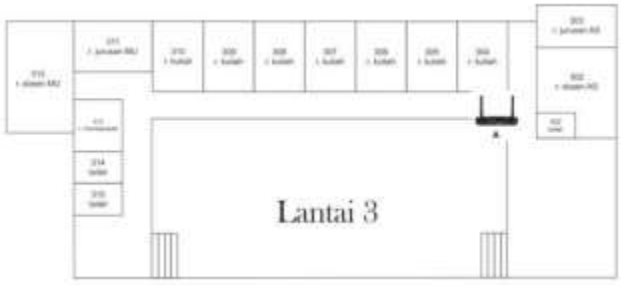

Figure 11. Good access point installment position on 3rd floor

Table 4. Bayesian probability calculation result for 4th floor

Position	Amount
A	0.288
B	0.251
C	0.264
D	0.276
E	0.29
F	0.283

From table 4 it is known that the choice of position from position A is position B, position C and position E with position F. At position B the value is less than position A so that the placement of a good access point in position B is 0.251. At position C the value is less than position D so that the placement of the access point is good at position C with a value of 0.264. At position F the value is less than position E so that the placement of the access point is good at position F with a value of 0.283.

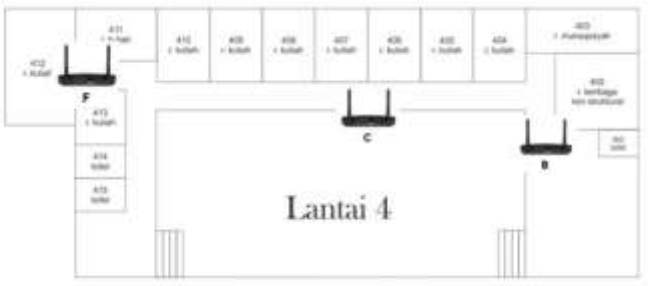

Figure 12. Good access point installment position on 4th floor

V. CONCLUSIONS

After conducting research on the placement of wireless access points on Wi-Fi signal coverage, it can be concluded as follows:

1. Design and research on the propagation and coverage of wi-fi signals on installed access points and actively used in the Syari'ah Faculty Building and Law. Data obtained by manual random sampling method so that the data is diverse and then processed using the method of Bayesian probability. Data obtained in the form of mac address, RSSI, distance, propagation, channel and standard protocol.
2. Signal coverage and propagation distance are the main factors in determining the position of a good access point, so that these factors are used in the calculation of bayesian probability.
3. By using the bayesian probability method, the result is that on the 3rd floor the position of the access point is good, that is at position A with a value of 0.424. Whereas on the 4th floor the position of the access point is good which is at position B with a value of 0.251, C position with probability value of 0.264 dan F position with probability value of 0.283. From the data from the research results, it shows that determining the position of the access point by the method of bayesian probability is successful, so that it can reduce the blank spot area.

ACKNOWLEDGEMENT

Thank you and thank you for the presence of Allah Almighty, who always bestows His mercy, guidance and blessings on us. Thanks also to parents, people closest to us who always provide moral and non-moral support, so we were able to complete this paper. To the ICID committee who have tried hard to organize this ICID event so that they can run as much as possible.

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